Designing a portable weather station

for use with

ALOHA

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INTRODUCTION

To predict how a cloud of pollutant gas might disperse in the atmosphere after an accidental release, the ALOHA air model needs information about prevailing weather conditions at the release site. Users can enter weather information manually into the model, but both the Macintosh and Microsoft Windows versions of ALOHA can also accept weather data from an external portable meteorological monitoring station, called a "Station for Atmospheric Measurements" (SAM). ALOHA can use SAM measurements of the wind speed and direction, the standard deviation of the wind direction, and the air temperature. ALOHA cannot accept relative humidity readings made by a SAM; humidity measurements must be entered into ALOHA manually.[1]

In the following pages, you'll find the information that you need if you plan to design a SAM that can be used with ALOHA.

DESIGNING A SAM FOR USE WITH ALOHA

Hardware guidelines

To be used effectively with ALOHA during responses to hazardous materials emergencies, a SAM should be portable, rugged, and easily set up by responders who may be wearing cumbersome protective clothing. A SAM intended for emergency response ideally should be mounted on a tripod or pop-up pole mounted to a response vehicle. During a hazardous materials emergency, responders sometimes may need weather data for long periods of time. A SAM should therefore be powered by a compact battery unit able to supply power for many hours without recharging. A SAM that can transmit data by line-of-sight radio frequency is well-suited for response because it can be positioned in a wide range of locations (ALOHA also accepts data transmitted by cable).

For use with ALOHA, a SAM must be equipped with a wind speed and direction sensor and an air temperature sensor. The wind sensor should have a measurement range from 1 to 70 miles per hour and a measurement accuracy of 1 percent. The temperature sensor

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[1] In addition, when using a SAM with ALOHA, the user must also enter values for ground roughness and cloud cover, and must indicate whether or not a low level inversion is present. If an inversion exists, the user must enter its height.

should report measurements to an accuracy of 1°C. A self-aligning compass on the anemometer, although not required, would be helpful to users.

The SAM should sample wind speed and direction at a rate of at least one sample every 2 seconds. It must transmit wind speed and direction and air temperature readings every 30 seconds. ALOHA expects each transmission to include:

- ❒ the most recent instantaneous measurements of wind speed, wind direction, and air temperature;
- ❒ 5-minute running averages of the wind speed, wind direction, and air temperature; and
- ❒ the standard deviation of the wind direction (see below).

Because air temperature does not change quickly over time, it may be sampled less frequently than wind speed and direction. ALOHA accepts data transmitted at 1200 baud, at settings of 8 bits, no parity, and 1 stop bit in comma-delimited ASCII format from a SAM through the computer's serial port. When data are transmitted by radio telemetry, the SAM manufacturer must include a receiver (transceiver) which connects to the computer's serial port.

Software guidelines

A SAM need not be user-programmable to be used with ALOHA. SAM software should perform the following functions:

- ❒ receive weather data;
- ❒ compute running 5-minute averages for wind speed and direction and air temperature;
- ❒ compute the standard deviation of the wind direction; and
- ❒ convert data to ASCII format for transmission through the serial port to ALOHA.

SAM data format

ALOHA expects data transmitted from a SAM to be formatted as follows. The SAM should transmit each data line in comma-delimited free field format:

<cr> <lf> ID,VS,WD,SD,TA,SP,DI,TI,B,CHK,

where <cr> = a carriage return (ASCII character code 13),

<lf> = a line feed (ASCII character code 10),

ID = the station identification number,

VS = the vector mean wind speed, averaged over 5 minutes (in meters per second),

WD = the vector mean wind direction, averaged over 5 minutes (in degrees true),

SD = the standard deviation of the wind direction (in degrees),

TA = the mean air temperature, averaged over 5 minutes (in °C),

SP = the instantaneous wind speed (in meters per second),

DI = the instantaneous wind direction (in degrees true),

TI = the instantaneous air temperature (in °C),

B = instantaneous SAM battery voltage (in volts), and

CHK = a checksum, computed by summing the ASCII values of all preceding characters in the data line, including the carriage return and line feed characters.

The instantaneous values included in each data line should be the last readings made by the SAM sensors before transmission of that data line. Each mean value should represent the arithmetic mean of the instantaneous readings made during the 5-minute period immediately preceding each transmission.   Note that although a met station ID number must be included in the data line, ALOHA displays but does not use this value.

If the SAM checks automatically for invalid data and finds an erroneous value, it should transmit a data line that includes, in place of that value, either no value (the data line would then contain two successive commas with no value between them, ",,") or a word such as "error" as its value for an invalid datum (the data line would then contain ",error,"). Because ALOHA does not check SAM data transmissions for unacceptable values, the SAM should not transmit a numeric value such as "999" in place of an erroneous value.

Computing the Vector Mean Wind Speed and Direction
Methods for computing the vector mean wind speed and direction are described in a guidance document prepared by the U. S. Environmental Protection Agency (1987). That document is available online at www.webmet.com/metmonitoring/table_of_contents.html .

You'll first need to collect N measurements of wind speed and wind direction. For purposes of computing means for transmission to ALOHA, N should be at least 150

(representing observations made no less often than every 2 seconds for 5 minutes). Follow the instructions in Section 6.2, "Wind Direction and Wind Speed" to compute the vector mean wind speed and direction (see especially www.webmet.com/metmonitoring/622.html).

Computing the Standard Deviation of the Wind Direction

Several methods exist for estimating SD, the standard deviation of the wind direction. One method, developed by Yamartino (1984) is described in U. S. Environmental Protection Agency (1987), and is shown online at www.webmet.com/metmonitoring/621.html .

REFERENCES

U. S. Environmental Protection Agency, Office of Air Quality Planning and Standards. 1987. On-site meteorology program guidance for regulatory modeling applications. Report No. EPA-450/4-87-013. Springfield, VA: National Technical Information Service, U. S. Department of Commerce. Version with minor revisions available online at www.webmet.com/metmonitoring/table_of_contents.html .

Yamartino, R. J. 1984. A comparison of several "single-pass" estimators of the standard deviation of wind direction. J. Climate Appl. Meteor. 23:1362-1366.